**BLOOD**

1 of the 3 parts of the cardiovascular system (other 2 are heart and blood vessels)

* Physical Characteristics
* Blood pH – 7.35-7.45 (because all metabolic reactions occur within this range – proteins might denature with more extreme variations of pH)
* Blood Temp - 38°C (100.4°F) this is known as the core temperature
* Blood volume – 4-5L (female)  
   – 5-6L (male)
* Blood Functions

1. Transportation (of nutrients and wastes)
2. Regulation (maintaining homeostatic balance)
3. Protection (cells that fight against foreign invaders, such as antigens)

* Blood Composition

1. Plasma (serum)

* Water (most abundant)
* Plasma proteins (such as albumin, globulin)
* Nutrients (monosaccharaides, vitamins, minerals)
* Electrolytes
* Metabolic Wastes (from body tissues; ie: urea, uric acid)

1. Formed elements
2. RBC – 99.9%
3. WBC – involved in body defense
4. Platelets – cytoplasmic fragments, important in clotting

* RBC (Erythrocytes)
* Biconcave (due to lack of nucleus) – 7.5µm diameter
* RBC counts – 4-5million/mm³ (female)  
   – 5-6million/mm³ (male)
* Hematocrit (Hct) (AKA PCV – packed cell volume) : 45%  
   - 42% (37-45%) (female)  
   - 46% (40-54%) (male)
* RBC Function
* Transport O2 and CO2
* Hemoglobin (Hb) (O2-binding molecule in erythrocytes)
* 2-Alpha + 2-Beta + 4 Heme = 4Fe (iron binds with O2)
* 250 million Hb per RBC!  
  Therefore each RBC can carry >1 billion O2 molecules!
* Hb Value:  
   14g (12-16g)/100mL (female)  
   16g (13-18g)/100mL (male)
* RBC Production (Erythropoiesis)
* RBC Lifespan: 120 days
* Erythropoietin from the kidney → Bone marrow → RBC production
* Hypoxia stimulates the kidney to release erythropoietin
* Dietary Requirements of RBC production:  
   Proteins, carbs, vitB12,iron, folic acid
* RBC Destruction
* Spleen – filters blood – its macrophages can detect old RBCs by their relative stiffness as compared to flexible new RBCs
* Recycling of RBC:

Globulin → amino acids  
Heme → Fe  
 → Bilirubin (bile)

* RBC Disorders
* Anemia (insufficient capacity to carry O2)  
  causes:

1. ↓ RBC counts

* Hemorrhagic anemia (blood loss)
* Hemolytic anemia (mismatched transfusion; toxicity)
* Aplastic anemia (from chemotherapy → Bone marrow destruction; treated with injections of synthetic erythropoietin)

1. ↓ Hb

* Iron-deficiency anemia (<1oz of red meat EOD can meet the iron req)
* Pernicious anemia = vit B12 deficiency  
  can be caused by autoimmune disease – you can bypass the absorption process (intrinsic factor) simply by giving injections of B12

1. Genetic Disorders

* Sickle cell anemia – mutated beta cells in Hb – causes joint pain because of trapped RBC’s unable to migrate into smaller blood vessels.  
  Sickle cell heterogeneity is protective against malaria, which may explain why the disease has perpetuated for so long
* Thalacemia – occurs in Mediterranean area – alpha and beta chains don’t match up – not a very severe disorder
* Polycythemia – too many RBC’s (which can indicate blood cancer)  
  This phenomenon also occurs as a response to being at a high altitude (the body compensates for lower O2 levels by producing more RBCs)
* WBC (Leukocytes)

1. Neutrophils (most common) – phagocytic cells
2. Eosinophils – phagocytic primarily to parasites
3. Basophils – responsible for allergic reaction
4. Lymphocytes – T-cells (killer cells) and B-cells (produce Antibodies)
5. Monocytes – precursor to macrophage

* WBC Production
* Colony stimulating factors
* Platelets (cell fragments)
  + Lifespan : 10 days
  + Counts: 250,000-500,000/mm³  
    if the count decreases too much, spontaneous bleeding occurs
  + Function : clotting
* Hemostasis (cessation of bleeding)

1. Vascular Spasm – damaged vessels constrict, directly reducing blood flow
2. Platelet Plug – platelets aggregate and self-adhere (positive feedback mechanism)
3. Coagulation
   * Clotting factors; form a chain reaction
   * Prothrombin → Thrombin → Fibrinogen → Fibrin (forms mesh over injured site)

* Disorders of Hemostasis
* Thromboembolytic Disease:  
   Thrombus (blood clot formation within intact vessel) → Thrombosis  
   Embolus (dislodged blood clot within intact vessel) → Embolism
* Bleeding Disorders

1. Thrombocytopenia = low platelets  
   CL - Petechiae
2. Hemophilia = clotting factor deficiencies
   1. Hemophilia A – Factor VIII
   2. Hemophilia B – Factor IX
   3. Hemophilia C – Factor XI

* All are X-linked, so this disease mostly affects men)
* Clotting factors can be supplied through transfusion
* ABO Blood Type
* Antigen (Ag) in RBC Membrane
* Antibody (Ab) a protein in the plasma designed to target and attack foreign antigens

|  |  |  |
| --- | --- | --- |
| **BLOOD TYPE** | **Ag** | **Ab** |
| A | AgA | Anti-B |
| B | AgB | Anti-A |
| AB | AgA and AgB | No Ab |
| O | No Ag | Anti-A and Anti-B |

* Rh Factor – a protein on the surface of RBCs  
  (Rh+ or Rh-) ie: blood types A+, A-,B+, AB- etc
  + Research on mysterious fatal hemolytic disease of newborns was performed on Rhesus monkeys (ergo “Rh” factor)
  + If a woman is Rh- and a man is Rh+, if they conceive a child the Rh factor can be passed from father to baby. If the baby’s blood then mixes with the mother’s blood, the Rh- mother’s body will make antibodies (AbRh+) for the Rh factor. If AbRh+ is then passed back to the baby’s blood it will attack the baby’s RBCs causing severe anemia and possible death ☹
  + An Rh- mother can be treated with RhoGAM (RhoIg) to prevent her from forming antibodies